Crosscut Hydro Plant
North side of Salt River
Tempe
Maricopa County
Arizona

HAER No. AZ-30

HAER
ARIZ,
7-TEMP,
4-

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

Historic American Engineering Record
Western Regional Office
National Park Service
U.S. Department of the Interior
San Francisco, California 94102

AZ-30-29 PRESSURE VALVE FOR NEEDLE GATE VALVE CONTROL
June 13, 1913

HAER
ARIZ,
7-TEMP,
4-

HISTORIC AMERICAN ENGINEERING RECORD

Crosscut Hydro Plant

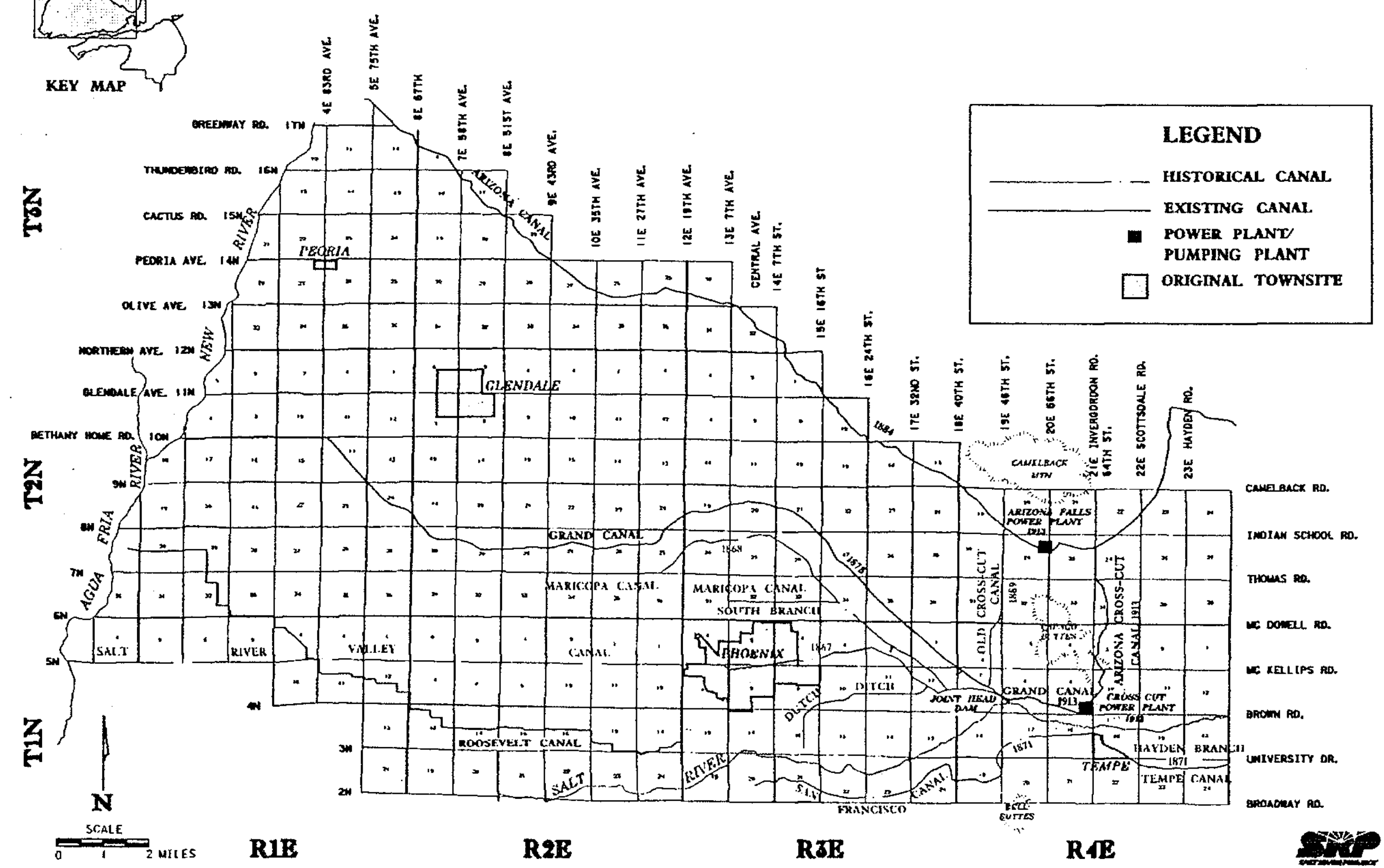
HAER No. AZ-30

Location:	On the north side of the Salt River in the city limits of Tempe, Maricopa County, Arizona UTM: 1351853.6/12139665.38
Dates of Construction:	Original construction - 1913-1914 Desilting basin built and conversion to 60 cycle - 1938
Engineers:	Construction in 1913-1914supervised by the U.S. Reclamation Service Supervising Engineer: William S. Cone Chief Electrical Engineer: O. H. Ensign
Present Owner:	United States Government and operated by the Salt River Project [SRP]
Present Use:	Generates a small amount of electric during heavy demand periods.
Significance:	This was the largest low-head hydro plant in the SRP system. From about 1915 to 1938, it represented a large percentage of the SRP generating capacity.
Historians:	Fred Anderson and Carol Noland Salt River Project Archives

MAP 1

CANALS OF THE SALT RIVER VALLEY: NORTHSIDE

(PAST & PRESENT)



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Although the Salt River Valley and the Phoenix Metropolitan area lie within a semi-arid, desert-like region of central Arizona, modern farming and urban development were made possible by the damming of the Salt and Verde rivers by the U.S. Bureau of Reclamation during the early 1900s. While the Salt River Valley was developing as a result of successful efforts to control the river's flow for irrigation, the young cities of the Valley were experiencing the social and technological changes of the late 19th century. One of these was the coming of the electrical age. The first widespread use of electricity in the Valley was to increase the amount of the irrigated acreage by pumping groundwater. Due to a lack of readily accessible fuel, valley citizens soon realized the importance of hydroelectric generation, and the Salt River Project (SRP) realized the importance of developing it. The Crosscut Hydro plant was the largest and most important low-head hydro plant built on the SRP canal system. It was also the center of the SRP electrical distribution system for many years. The hydro plant was built at the head of the Grand Canal (see HAER No. AZ-17) and has always been operationally dependent on the flow of water through the Grand Canal to generate power.

Early Hydropower Development

The first Arizona hydro plants were located on falls in canals. By 1902 there was a plant located at Arizona Falls on the Arizona Canal operated by the Phoenix Light and Fuel Company, and another plant at the site known as Chandler Falls where the Tempe Crosscut dropped off the mesa into the Tempe Canal. A third plant was under construction by Phoenix Light and Fuel on the Salt River Indian Reservation about two miles west of Granite Reef Dam, where water from the Arizona Canal was diverted to a drop and then back into the river bed.[1]

The earliest plans for Roosevelt Dam included hydro generation of electricity which would be used in the construction of the dam and later used for Project pumping plants, or sold. The sale of power was a very practical way to reduce the construction and operation costs of the project. After the irrigated acreage of the Valley was expanded by the dam, electricity for pumping took on a new importance. The application of irrigation water to larger areas of land resulted in the raising of the water table to a point where thousands of acres were nearly waterlogged. Thus the most important use of pumping in the first two decades of SRP operation was not for increasing agricultural acreage per se, but for saving existing

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[1] Earl Zarbin, "The Salt River Project: Generating Electricity," (manuscript, n.d., SRPA), p. 3.

acreage by draining it. Of course this drainage water was quickly put to use by farmers outside the Project boundaries.

Power was generated at Roosevelt from two different heads. A 19 mile long power canal took water from the Salt River above the upper end of Roosevelt Lake, and delivered a constant head of 220 second/feet. In addition, an intake at the dam provided a variable head when water was discharged from the dam for irrigation. The two sources entered the power house below Roosevelt Dam through separate penstocks, and each drove three 900 kilovolt (KV) turbines. Commercial operation of the plant began with the first transmission of power to Phoenix in 1909, and slowly increased to 6000 KW capacity by 1913.[2]

It soon became apparent that electrical demand would grow far beyond the capacity of the Roosevelt plant, and that there were numerous other feasible hydropower sites on the Project water delivery system. The Reclamation Service was responsible for building the Project, and in many ways exercised its powers not only to direct the construction, but to determine the ultimate size and purpose of the Project. This was particularly true of the power system which, as Zarbin says, remained "firmly in the hands of the Reclamation Service, and not the Water Users' Association," at least until 1910. In 1907 the government acquired the Arizona Falls and Indian Crosscut plants from Pacific Gas & Electric, and agreed to provide the company 1500 KW for retail sale in Phoenix. The government promised not to enter into retail sales itself, but reserved the right to serve large industrial customers.[3]

The government also built an electrical distribution system. The main artery was the 44,000 volt (44 KV) line from Roosevelt to the Mesa Switchyard and the Phoenix Substation. The first branch off this line was the Sacaton 44 KV line, completed in 1910 to supply the pumping plants on the Gila River Indian Reservation for which a power supply contract was signed in 1907, as well as the Chandler pumping plants. Over the next several years, 44 KV extensions were built from the Mesa Switchyard to the South Consolidated Power Plant (built in 1912); from Phoenix to Glendale, mainly to supply the South-Western Sugar & Land Company; and from Roosevelt to Miami to supply the Inspiration Consolidated Copper Company. In addition, 11 KV lines were built connecting the canal hydropower stations and pumping batteries, and a few 4.5 KV lines to supply smaller customers in Phoenix and

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[2] James M. Gaylord, "Power and Pumping System of the Salt River Project, Arizona," (manuscript, 1914, SRPA), pp. 6-11.

[3] Zarbin, "Generating Electricity," p. 23; Geoffrey P. Mawn, "Phoenix, Arizona: Central City of the Southwest, 1870-1920," (Ph.D. diss. Arizona State University, 1979), p. 337.

Glendale. The layout of these main lines shows the importance of commercial customers and pumping plants in establishing the SRP power system.[4]

The 1910 Agreement

Although the Water Users' Association saw the advantages of power generation, the overall cost of the project was already soaring far above the original estimate of about $3 million, and there were no other funds available from the Reclamation Fund for expansion of power generation. In October 1909, with the anticipated completion of Roosevelt Dam still two to three years away, Association legal adviser Joseph Kibbey proposed to the Board of Governors that the Water Users' Association build hydropower plants on the canals and sell the electricity to reduce the repayment costs. According to this plan, Association members would assess themselves about two dollars per acre for three years to pay for the plants. The sale of electricity would produce revenue of $300,000 to $500,000 per year, which, it was assumed, would reduce Project repayment charges from about $4.50 per acre per year, to about $2.50 per acre per year, once the 10 year repayment period began.[5] By May 1910, this idea had been formed into a definite proposal for the consideration of the Interior Department. Under this proposal, the Water Users' Association would:

1. Build a new crosscut canal from a point on the Arizona Canal one mile above Arizona Falls to a point near Hole-in-the-Rock northwest of the Mill Avenue Bridge in Tempe.

2. Extend the Grand Canal approximately two miles east to meet the new crosscut, and enlarge the upper end of the existing canal.

3. Build a 6000 horsepower (HP) hydro generating plant at the fall between the new Crosscut and the Grand extension.

4. Build a 3000 HP hydro plant on the South Canal at the junction of the Consolidated Canal, with a transmission line to the Mesa Switching Station.

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[4] Gaylord, "Power and Pumping," pp. 113-130.

[5] Under Reclamation law, the 10 year repayment of construction costs began when the project was declared "open" by the Secretary of Interior. Kibbey hoped to build and pay off the hydro plants before these repayments began, which was easily accomplished. The project was not declared open until 1917 (by which time the repayment period had been extended to 20 years).

5. Refurbish the existing Arizona Falls plant to generate 700 HP.

The estimated cost of this work was about $900,000. The proposal was approved by the Interior Department, and a contract was executed which also provided that the Salt River Project would not be declared open at least until the power plants were completed. The work was to be directed by the Reclamation Service, and when completed would be turned over to the federal government to become part of the Salt River Project. On July 21, 1910, Association shareholders approved the contract in a special election, and the Board levied an assessment on member lands of $2.25 per acre for two years.[6]

These power projects required acquisition of rights of way, designing of facilities and specifications, solicitation of bids and letting of contracts before construction began. The bidding on hydropower equipment was particularly cumbersome, since all the equipment suppliers were located far from Phoenix, and many of the installations were custom-made. Furthermore, almost all correspondence related to power construction was routed through Chief Electrical Engineer O.H. Ensign at the Reclamation Service office in Los Angeles. Work on the South Canal plant began in 1911, and operation of the plant began in November 1912. Work on spillways at Arizona Falls began in January 1912, and work on a new powerhouse began in June. The plant went into operation in May 1913.

Work on the Crosscut project began with the building of the three and one-half mile long New Crosscut Canal. The reasons for relocating the interconnection between the Arizona and Grand canals had to do entirely with power development rather than irrigation. By moving the crosscut east, it was possible to take advantage of a 112-foot drop (the maximum flow of the canal was 720 cubic feet per second), at the point where the Crosscut would meet the new head of the Grand. Also, the Crosscut power station would act as the central distribution station for the entire system, connecting Arizona Falls with the southside system and the main line from Roosevelt to Phoenix.[7]

Despite the primacy of power generating considerations in the development of the Crosscut project, the fact remained that the first purpose of the Salt River Project was irrigation, and therefore, the plant was "designed not to vary the water to suit

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[6]Zarbin, "Generating Electricity," pp. 64-80; Project Director to Director, USRS, August 31, 1911; Contract of August 30, 1910 (both SRPA).

[7]"Power Situation on the Salt River Project, Arizona," by Chief Electrical Engineer, Los Angeles, California, 1914 (SRPA).

the demands of power but to vary the water to suit the delivery of the water, and to get every pound of power out of that water." Thus the plant was designed to achieve maximum efficiency under varying loads.[8]

Bids on the new canal were opened on March 28, 1912, with Grant Brothers Construction the successful bidder. The first three thousand feet of the canal below the Arizona Canal crossed a depression which at its lowest point was eleven feet below the required grade for a canal. The Reclamation Service produced designs for both an underground pipe and an elevated, lined canal in this stretch before deciding to build the latter (see photo AZ-30-18). The lower end of the canal crossed a 500 foot ravine in a concrete flume supported on concrete bents, to a saddle between two hills, where it emptied into a long concrete forebay 380 feet long by 58 feet wide. The purpose of the forebay was to hold a steady head of water for power generation, and more important, to allow the water to settle and drop its silt and sand to the floor of the forebay. The spillway wall contained small gates which could be opened periodically to flush sediment out of the forebay.[9]

At the lower end of the forebay were the mouths of two parallel seven-foot wide concrete penstocks, 2240 feet long which conveyed the water to the power plant (see photo AZ-30-7, AZ-30-9). The penstocks were reinforced with longitudinal 1 1/4 inch steel bars and circumferential rods. Every 300 feet the penstocks were anchored into concrete pads which were poured with the pipe. The penstocks were covered with earth and broken rock to a depth of twelve inches above the crown. The work on the penstocks was done under contract by Martin & Gillis from March to December 1913. This company also built the penstock entrance and installed the butterfly regulating valves.[10]

Construction of the Crosscut Hydro Plant

Contract for the construction of the power plant building was let to Martin and Gillis July 21, 1913 (see Table 1). Construction began in late September, and was completed in November, 1914 (see photo AZ-30-1). The equipment consisted of six 1000 HP Pelton Turbines connected to six vertical shaft Westinghouse 11,000 volt generators of 700 KW capacity. Each penstock drove three main water wheels and an exciter unit

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[8]Chief Electrical Engineer to Water Users' Association, February 2, 1914 (SRPA).

[9]SRP Annual History 1912, 1913.

[10]Ibid., 1913.

(photos AZ-30-19, AZ-30-20, AZ-30-21 show the layout and relationship of the equipment). The main units were each turned by six nozzles, each with a maximum capacity of 20 cubic feet per second, which could be opened and closed individually by hand-operated needle valves. A governor, driven by pulleys from the top of the generator, controlled the opening and closing of deflectors in front of each nozzle. This affected the force of water striking the water wheel blades. This governor and deflector system was the mechanism by which electric load was derived from variable heads of water. The water wheels were custom-made to handle the expected large amount of sand and silt in the water: the number of parts most susceptible to wear was reduced, and they were designed for cheap replacement (see photo AZ-30-2 for a view of the original generators and exciters, including the governor pulleys and belts; and photos AZ-30-20, AZ-30-21, AZ-30-22, AZ-30-25, AZ-30-26, AZ-30-27 for drawings of the details of the water wheels, deflectors and nozzles).[11]

The generators were connected to the water wheels by a straight shaft with split clamp couplings. The weight of the rotating parts of the wheel and generator totaled 23 tons, and was suspended from the top of the generator by a single Kingsbury thrust bearing twenty four inches wide. The lower end of the water wheel-generator shaft was held in place by a spider bearing (See photos AZ-30-23, AZ-30-24). The transformers, switches and bus bars were housed in adjacent rooms east of the generator room. The twelve transformers, produced by Allis-Chalmers Manufacturing, were oil-insulated and cooled by circulating water. They were connected to double 11,000 and 45,000 main bus lines through Westinghouse switches (photo AZ-30-3).[12]

By spring 1914, the building was largely complete, and installation of machinery had begun. The most critical part of the process was the placement of machinery which had to be set in concrete or grouted in position. All summer long a flurry of correspondence between Chief Electrical Engineer Ensign and Superintendent of Construction William S. Cone in Phoenix was generated by the concerns over placement of the needle valves and nozzles, and the alignment of the water wheel, shaft, bearings and generator. The specifications for the placement of the generator sole plate, which was to be grouted into position, were detailed as to the method of shimming and bolting to be used, and the tolerances needed: "Extreme care should be taken by the man using the engineer's level (transit) to be certain that the rod is held absolutely vertical, and that he is looking for a difference less than the diameter of his cross hairs." Specifications also called for a variation of less than one

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[11]SRP Annual History, 1913, 1914.

[12]Gaylord, "Power and Pumping," pp. 104-111.

one-hundredth of an inch in the centering of the needle valve shaft in its seat.[13]

By September all the water wheels and generators were installed, and the pipes and chambers were filled with water to test for leaks. When small leaks caused by shrinkage cracks were found, the pipes were refilled with "as dirty water as we could get," mixed with sawdust, to fill in the hairline cracks. In testing the needle valves, a serious vibration was discovered during the opening of the valves. These valves were intended to be operated only in a full open position, but had to be opened and closed slowly enough to prevent abrupt changes in water pressure in the pipes. The problem was that when operated slowly under a full head of water, the valves were subject to a vibration or "chattering" which could damage the valve seats and stems, and even crack the concrete around the stem guides. Ensign calculated that if the valve could be opened and closed so that it passed through the vibration zone in three to five seconds, the water pressure rise would be acceptable. During October and November, the Pelton Company and the Reclamation Service Engineers experimented with several ways to alleviate this problem, and in November installed new valve guides with vanes which prevented the eddies which caused the vibration.[14]

There were also problems with the butterfly valves at the penstock entrances, and with the efficiency of the water wheels, which at first seemed to be "drowning" in the backwash of water from the nozzles, so that the turbines were operating more efficiently with four jets open than with all six. Work on all these problems was complicated by the operation of one penstock and three turbines for generating purposes, beginning December 19, 1914. This was done to take advantage of the flood flows of the Verde River, which allowed the Roosevelt plant to be shut down to store water. This operation of the untested plant resulted in damage to several of the needle valves and water wheels. Eventually so many of the valves were damaged that the

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[13] "Specifications for Erection of Apparatus for Crosscut Plant," c. June 25, 1914, by O.H. Ensign; Ensign to Superintendent of Construction, Phoenix, Arizona, June 26, 1914 (both SRPA).

[14] Chief Electrical Engineer to Superintendent of Construction, October 14, October 19, 1914; Superintendent of Construction to Chief Electrical Engineer, October 8, November 23, 1914 (all SRPA).

TABLE 1: SPECIFICATIONS, CROSSCUT HYDRO PLANT, 1914

Water Wheels (6)	
Maximum capacity	1000 HP
Speed	94 RPM
Guaranteed maximum efficiency	75%
Exciter Water Wheels (2)	
Maximum capacity	300 HP
Speed	150 RPM
Guaranteed maximum efficiency	75%
Governors (6)	
Speed regulation	2%
Speed fluctuation, full load off	10%
" " full load on	12%
" " half load off	6%
" " half load on	8%
Price of complete hydraulic equipment, FOB San Francisco	$73,365
Generators (6)	
Rated capacity	875 KV-A 700 KW @ 80% PF
Rated temperature rise (guaranteed)	40 deg. C.
2-hour overload capacity	1094 KV-A
Overload temperature rise	50 deg. C.
Full load efficiency	93.5%
Weight	78,000 lb.
Price FOB Pittsburgh	$9233
Exciter Generators (2, 200 volt)	
Rated capacity	200 KW
Temperature rise	50 deg. C.
2-hour overload capacity	250 KW
Overload temperature rise	65 deg. C.
Full load efficiency	90%
Price FOB Pittsburgh	$3993
Transformers (12, oil insulated, water cooled)	
Rated capacity	500 KV-A
2-hour overload capacity	625 KV-A
Full load efficiency	97.7%
Regulation	1.2% 100 PF
Weight	15,200 lbs
Cooling water required	2.5 gal/minute
Primary voltage ratio	23,100-40,000 V
Secondary voltage	10,500-11,500 V
Price FOB Norwood, Ohio	$1350 ea.

SOURCE: Gaylord, "Power and Pumping System of the SRP."

TABLE 2: CONSTRUCTION COSTS, CROSSCUT HYDRO PLANT, 1914-15

Forebay	
Concrete and materials	$ 3,922
Grant Bros. contract	10,675
Butterfly Valves (Penstock)	
Machinery & materials	3,175
Martin & Gillis contract	4,384
Penstocks and Water Passages	
Concrete and materials	5,150
Martin & Gillis contract	33,621
Supplemental work	10,334
Water passages	
Concrete and materials	4,261
Martin & Gillis contract	34,588
Steel	20,391
Building	
Excavation	30,779
Martin & Gillis contract	43,069
Miscellaneous	2,522
Water Wheels	73,365
Generators	92,365
Freight	17,000
Testing	32,265
Installation (Water Wheels, electrical, etc.)	18,072

Source: USRS Correspondence, SRPA.

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valve stem was redesigned and strengthened (see photo AZ-30-28).[15]

Through the rest of 1915, work continued on the various problems with the plant. Most of this work was done by the Pelton Company under the fulfillment of their contract to achieve required efficiency and reliability. The contract between the Water Users' and the Reclamation Service called for a thirty day

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[15] Superintendent of Construction to Chief Electrical Engineer, January 8, 1915 (SRPA).

test of the plant before acceptance by the Water Users' Association. This test was not begun until December 15, 1915. Although not considered fully operational, the plant generated a total of 8,290,000 KWH in 1915, operating on only one penstock at a time. This was the second largest production of any SRP hydro plant that year, only 15 per cent less than the output of the Roosevelt plant.[16]

A summary of costs issued June 1, 1915, showed a total cost of $424,000, not counting changes requested by the Water Users' Association (see Table 2). The original estimate had been $411,000.[17] Freight costs ($17,000) were high, undoubtedly due to the remoteness of Phoenix from industrial suppliers. The combined installation and testing cost of over $50,000 reflects the fact that there was a great deal of work done in modifying and adjusting the equipment. This is reflective of the innovative nature of the plant, as summed up by Ensign:

> The designing of a plant of this kind to meet the peculiar conditions of water flow and hold the efficiency and all other desired characteristics, without interfering with the water flow, such as we are doing at the Cross Cut Plant, requires a considerable concentrated skill and experience. Yet, it being quite radical in some features from previous plants, little things are likely to develop that are annoying and perhaps more or less costly to the contractor. . . but I am still confident that the plant will come through high in efficiency.[18]

Growth of the SRP Power System

At the time it was put into service, the Crosscut Hydro Plant supplied about 40 per cent of the generating capacity of the SRP system. For the next twenty-four years the plant operated as a generally reliable power source, despite increasing evidence that some features of the plant were less than ideal. The Pelton water wheels did not operate well on the low head available, and numerous problems were experienced with the transformers and distribution equipment at the plant.

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[16] SRP Annual History, 1915, pp. 44, 47.

[17] Chief Electrical Engineer to Chief of Construction, Denver, Colo., June 1, 1915 (SRPA).

[18] Chief Electrical Engineer to Superintendent of Construction, February 18, 1915 (SRPA).

Nevertheless, this was a period when the Crosscut experienced "many repairs but little change."[19]

The Association's operation of the power system, however, underwent great change (the Salt River Water Users' Association took over operation of the Salt River Project by contract with the Federal Government dated September 6, 1917). Project pumping and wholesale and industrial power sales both increased greatly during the World War, but the power supply remained dependent on the flow of water, and the flow of water was determined primarily by the weather and irrigation needs. This meant that during the winter months, when the water stored behind Roosevelt Dam was not needed for irrigation, those generators were not available. At those times, power could be generated by the canal hydro plants using Verde River water, but even these sources could be cut off by a general drought on the watershed. The SRP hydroelectric facilities lay within easy reach of some 80 per cent of the 1920 electric load of the state of Arizona, and that load was growing rapidly. While this represented an opportunity, it also represented a threat. If the Association did not take steps to expand and firm up its electrical capacity, some competitor was sure to expand into the Project area. The Water Users' had an investment of $4.5 million in electric generating plant to protect, and the opportunity to further reduce per-acre assessments on Association farmers through increased power revenues. As Association President Frank Reid put it:

> We are in the power business. We cannot afford to stay out of the power business with the large and growing demand for pumping on our project and power needs on the farm. Never in the history of the Valley has there been a greater need for vision on the part of the members . . . to see this great opportunity of our Association.[20]

Association management considered the best solution to this problem to be the expansion of hydro generating capacity by building more power generating dams on the Salt River. Between 1923 and 1929, three hydroelectric/storage dams were built on the Salt River between Roosevelt Dam and Granite Reef Dam. They were Mormon Flat Dam (begun 1923), Horse Mesa Dam (begun 1924), and Stewart Mountain Dam (begun 1928). This allowed water to be run through the upper dams for power generation and still stored

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[19] W.J. Grasmoen and H.F. Hudson, "Cross Cut--Forty Years of Power Plant Progress" (conference paper, AIEE Pacific General Meeting, August, 1952).

[20] F.A. Reid to the Members of the Council, Salt River Valley Water Users' Association, November 16, 1922 (SRPA); David M. Introcaso, "Mormon Flat Dam," Historic American Engineering Record Report No. AZ-14 (1989), Chapter 2.

behind the lower dams for irrigation. It also expanded the total hydro generating capacity of the Association from about 22,100 KW to 69,500 KW. The dams were financed by bond issues based on contracts to deliver power to industrial users, especially the mines in Globe, Miami and Superior, and to Central Arizona Light and Power Company (CALAPCO). A 1928 contract to deliver 7000 KW of firm power to CALAPCO, added to 9500 KW previously contracted for, brought the minimum annual revenue from that source up to $240,000. This increased revenue made possible the $4.1 million bond issue to finance Stewart Mountain Dam. $1.44 million of this financing was used for the Association's rural electrification program. The construction of 712 miles of 4 KV line and eight substations made it possible to bring electric power to 4200 Association members, making the Salt River Project "the largest completely electrified rural area in the world." Sales to farm customers added approximately $250,000 to Association power revenues.[21]

In 1929, continued drought endangered hydropower generation and led to power supply contracts with CALAPCO and the Inspiration Consolidated Copper Company. CALAPCO agreed to build a steam generating plant in Phoenix primarily to supply Association commitments, in return for guaranteed minimum payments through 1938. The Association also paid the total cost of the expansion of the Inspiration Consolidated steam turbine capacity ($463,000) in return for availability on demand of the expanded capacity through 1939. In addition, the Association was able to purchase as much as 14,000 KW from the Arizona Power Company's plants in Childs and Prescott ("wheeled" by CALAPCO).[22]

Expansion and Modernization of the Crosscut Facility

With the pending expiration of the CALAPCO and Inspiration Consolidated contracts, the Association made plans to build its first non-hydro generating plant, and to modernize the Crosscut Hydro Plant. A 1937 report by a consulting engineer recommended the purchase of diesel generating units to provide 15,000 KW of standby power and the testing of the canal hydro units to determine whether upgrading these plants was feasible. Construction of the diesel plant began in October 1937, and in 1938 two 6250 KVA, 25 cycle diesel generators were installed. Over the next 12 years, the Crosscut complex added and removed at different periods a total of three more diesel units and added

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[21]Barry Dibble, "Engineering and Economic Examination of SRVWUA, Salt River Project, Arizona," (1935, SRPA), pp. 7-15; the rural electrification claim is made in Grasmoen and Hudson, "Cross Cut."

[22]Dibble, "Engineering and Economic Examination," pp. 13-15.

four steam turbine units. The hydro, diesel and steam units were all connected, and the changes at Crosscut were almost continuous over this period (as this report was being written, plans were underway for a Historic American Engineering Record report on the Crosscut Steam Plant).[23]

To this point all the generating capacity of the Project had been 25 cycle frequency, but the eventual conversion of the system to 60 cycle was recognized. The first step in this direction was taken primarily to serve a single large customer, the City of Mesa, which had a 60 cycle system powered by an obsolete and inadequate frequency changer. The Association desired to begin supplying 60 cycle power directly. In 1938, hydro units 4, 5 and 6 were decommissioned, and the penstock to unit 4 was reworked to accommodate a 4100 HP, 327 RPM water wheel built by James Leffel & Co. This was attached to 3750 KVA, 60 cycle vertical shaft generator, 3000 KW capacity, produced by Electric Machinery Manufacturing Co (see photo AZ-30-5). In 1940, a 9000 KVA frequency changer was installed in the space formerly occupied by hydro units 5 and 6 to convert between 25 and 60 cycle (photo AZ-30-6).[24]

Also as part of this project, a 21 acre-foot desilting basin was built on the east side of the forebay, to further reduce the entry of sand into the penstocks. This was created by a concrete dam 30 feet high and 300 feet long (see photos AZ-30-7, AZ-30-8, AZ-30-9). The dam was built of arches on 25 foot centers, designed not as a multiple arch dam, but as a structure of "heavy horizontal piers with expanded upstream ends acting as corbells and meeting in the center." This was the first use of "low-water-cement-ratio" concrete on an Association construction project, and "went far toward breaking down a residual feeling among some Association concrete men in favor of the old wet mixes." The new generator had a contract price of $44,400; the Leffel water wheel (see photo AZ-30-4) had a contract price of $42,400, including governor system; the desilting basin dam was designed by consulting engineer Raymond A. Hill, with a contract price of $36,000. Other less-expensive designs for the dam were rejected because they were less well suited to the capability of the Association workforce, in Hill's opinion.[25]

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[23]W.R. Elliott to Lin Orme, October 4, 1937 (copy in Engineering Section, SRP Annual History, 1937); SRP Annual History, 1938.

[24]File: Crosscut Conversion, Box 6-4 (SRPA).

[25]SRP Annual History, 1938; File, Crosscut Conversion, Box 6-4 (SRPA). Raymond Hill was the son of Louis C. Hill, the Supervising Engineer who oversaw the original construction of the
(Footnote Continued)

In 1950 the Salt River Power District (as the electrical department of the Project was then known), began a concerted effort to convert all its facilities to 60 cycle power (except service to the mines). Also that year the District began construction of the Kyrene steam generating plant, a modern, outdoor type facility which vastly increased the generating capacity of the Project. The three remaining 25 cycle units at Crosscut continued to be used through the mid-1950s, then were decommissioned and removed. The 60 cycle unit continued to be used as a small peak-load unit during the summer. The building was used for storage and part of it was converted into a hydrology laboratory. After several years disuse, the 60 cycle unit was renovated in 1976 and has been used ever since (through 1990). As always, the generation is dependent on surface water irrigation flow of the Grand Canal. The unit is run continuously from May to September at extremely low cost and displaces up to 3000 KW of the most expensive power source then operating, realizing considerable savings in SRP generating costs.[26]

(Footnote Continued)
Salt River Project, including the Grand Canal extension and the Crosscut Hydro plant.

[26] Interview with Tom Kouts (SRP Power Operations Department, August 21, 1990).

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